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Publisher Taylor & Francis

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## Food Additives & Contaminants: Part A

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title-content=t713599661>

### Meeting the challenges of toxic microorganisms and pathogens: implications for food safety and public health

Online Publication Date: 01 September 2008

**To cite this Article** (2008)'Meeting the challenges of toxic microorganisms and pathogens: implications for food safety and public health', Food Additives & Contaminants: Part A, 25:9, 1047 — 1049

**To link to this Article:** DOI: 10.1080/02652030802367080

**URL:** <http://dx.doi.org/10.1080/02652030802367080>

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## FOREWORD

### Meeting the challenges of toxic microorganisms and pathogens: implications for food safety and public health

The 10th International Symposium on Toxic Microorganisms, organized by the US–Japan Cooperative Program on Development and Utilization of Natural Resources, Joint Panel on Toxic Microorganisms, was held on 7–9 November 2006 at the USFDA Center for Food Safety and Nutrition in College Park, Maryland. As suggested by the title, longstanding and emerging challenges must be met to protect animals and humans from illnesses arising from feed- or food-borne pathogenic and toxigenic microorganisms. These challenges are being addressed on multiple levels, ranging from epidemiological studies to assess exposures in populations, to developing faster, more reliable analytical methods, to toxicological investigations for understanding the mechanisms of food-borne diseases, to elucidating the genomes of the causative microorganisms. The selection of symposium presentations in this special issue of *Food Additives and Contaminants* illustrates ongoing multidisciplinary research in these and other areas that contribute to protecting the public from the adverse effects of pathogenic and toxigenic microorganisms.

Several presentations covered aspects of the epidemiology of microbial food-borne illness. Militotis et al. discussed how Microbial Risk Assessment (MRA) can be used as a systematic tool that allows an evaluation of exposure, the resultant impact of exposure on consumers' health, and potential intervention or control measures. They also discussed the use and limitations of epidemiological data in the development of a valid MRA. Toyofuku focused on the epidemiology of *Salmonella* poisonings in Japan from 1998 to 2004 and, using these data, looked at the challenges in developing effective risk-mitigation strategies. He further suggested potential improvements in data-gathering activities that could contribute significantly to reducing *Salmonella* food poisonings further. New modelling techniques are needed for rapid detection and response to food poisoning outbreaks. Jaine addressed this need by discussing a computerized model that uses a structured, phased form of pathway

analyses to model the entire evolution of food-borne illnesses. From the results obtained from the models, the consequences of various scenarios arising from an outbreak as well as the optimal ways to intervene and control those consequences could be proposed.

Microbial resistance to antibiotics has become an increasingly important concern. Two presentations on antimicrobial resistance patterns illustrating two different, but related, challenges for food safety and public health were presented. Igimi et al. reported Japanese data on trends in antimicrobial resistance patterns in *Campylobacter* and, in this regard, the reported trend in resistance to quinolones in animal and human isolates was of particular interest. Akiba et al. illustrated the changing patterns of antimicrobial resistance of *Salmonella enterica* serovar *typhimurium* isolated from cattle in Japan. Their studies suggested that resistance patterns have been affected by a clonal exchange of *S. typhimurium* among cattle and that the contemporary strains show a remarkable degree of homogeneity with DT104 at a molecular level.

Challenges in understanding the mechanisms of action of virulence factors in specific organisms were discussed by Okada et al., who reviewed the genetic basis for the strong osmotolerance associated with *Listeria monocytogenes*. While the authors noted that much more genetic analysis is needed, studies using a variety of mutant strains have opened new insights into the osmotolerance of this important food pathogen and it is expected that, as understanding increases, more efficient control methods for *L. monocytogenes* may be developed.

Phillips and Abbott discussed high throughput enzyme-linked immunoabsorbant assay (ELISA) electrochemiluminescent detection of botulinum toxins in foods, a method that addresses the challenges involved in the rapid laboratory analysis for this food-borne toxin and its relevance for food safety and defence purposes. While the mouse assay remains the gold standard test for the presence of botulinum toxins, it has long been recognized that faster, less expensive methods with higher throughput are needed

to deal effectively with outbreaks. Phillips and Abbott evaluated an electrochemiluminescent assay (Bioverify® Assay): the ease of operation, limited sample preparation and low detection limit should make it an excellent option for detecting these toxins in food matrices.

Phycotoxins are also a significant food safety and public health concern. Yessotoxin (YTX) is one of several algal metabolites that have been linked with diarrhetic shellfish poisoning (DSP) and that have been gaining increased attention. Tubaro et al. updated recent findings that address the on-going issue of whether or not YTX in contaminated food can cause skeletal muscle toxicity. The results of their *in vitro* and *in vivo* studies seemed effectively to exclude a toxic effect in skeletal muscle when YTX is consumed as a food contaminant.

Mycotoxins are an important feed and food safety concern. Monitoring their concentrations in foods and assessing their intake is an important contribution to minimizing the risks of mycotoxins to consumers. Kumagai et al. reported the results of surveys that assessed aflatoxin and ochratoxin A concentrations in retail foods from Japan and estimated exposures to these mycotoxins through the consumption of products containing cacao.

Reducing mycotoxin levels in commodities and foods is an ongoing, challenging area of research and various physical, chemical and biocontrol methods for this purpose continue to be proposed and investigated. The ability of ultraviolet light to kill moulds has been demonstrated and, using an *in vitro* bioassay, Murata et al. demonstrated the conditions under which ultraviolet light reduces the amounts and biological activities of two agriculturally important mycotoxins, zearalenone and deoxynivalenol. Their findings pave the way for further experiments to test the method's usefulness for contaminated feeds. Yabe et al. have isolated a compound, cyclo(L-leucyl-L-prolyl), from *Achromobacter xylosoxidans* that inhibits aflatoxin production by *Aspergillus parasiticus* at an early step in the biosynthetic pathway. Their key experimental results and the methods used to isolate and investigate the compound are reviewed in their report.

Mycotoxin monitoring depends upon the availability of validated methods. Mycotoxin reference materials are useful tools for collaborative studies to validate analytical methods and otherwise to compare results among cooperating institutions. Suitable reference materials are, however, not readily available for many mycotoxins or their precursors. One such compound is sterigmatocystin, a rodent carcinogen

and the biosynthetic precursor of aflatoxin B<sub>1</sub>. Tanaka et al. have described a simple method for producing an acceptably homogenous reference material for sterigmatocystin from a culture material of *Aspergillus versicolor*.

Toxicology has played an important role in characterizing the diseases caused by mycotoxins by identifying organ-specific and pathophysiological effects, determining dose-response, and elucidating the mechanistic events that are involved. Sugita-Konishi et al. presented their toxicological findings on the haematological, reproductive and other effects of the trichothecene, nivalenol in mice. Their results, which include the establishment of lowest observable effect levels (LOEL), contribute to the information base for the risk assessment. In another presentation devoted to trichothecenes, Pestka reviewed the molecular events involved in the induction of immunological effects and apoptosis by deoxynivalenol. His report also provided a review of key signal transduction events involved in the activation of mitogen activated protein kinases (MAPKs), which in turn play a key role in modulating trichothecene cytotoxicity.

Advancements in fungal genomics have led to a better understanding of fundamental fungal biology and can ultimately make important contributions to research aimed at reducing mycotoxins in commodities. For example, the identification of key genes and elucidating the conditions for up- and down-regulation of the genes involved in mycotoxin biosynthesis, fungal growth, and plant pathogenicity can provide valuable clues for the identification of potential 'control points'. One approach contributing to this goal is the comparison of genomes from closely related mycotoxigenic and non-toxigenic fungi, as illustrated in the presentation by Machida et al. Their paper was complimented by the report by Yu et al. on the identification of *Aspergillus flavus* genes that are involved in aflatoxin production and on the construction of *A. flavus* genetic microarrays for use in research. The potential power of a genomic approach is further illustrated by Brown et al., who have been using genome sequencing, expressed sequence tags, and microarrays to reveal genes of *Fusarium verticillioides* that are involved in the biosynthesis of fumonisins and in the plant pathogenicity of this common fungus.

There is no doubt that microorganisms have a major impact on food safety and public health. While certainly not a comprehensive review of all ongoing initiatives to reduce the risk of diseases related to food-borne microorganisms or their toxins, the

presentations in this issue nonetheless highlight some of the important approaches, and their implications, that contribute to this goal.

The UJNR panel members thank all who helped organize, host, and otherwise support the panel's 10th International Symposium on Toxic Microorganisms. We are particularly grateful to the symposium participants and to *Food Additives and Contaminants* for making this selection of papers available to those interested in food safety and public health issues related to toxic microorganisms.

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